

Renewable Energy in the UK

The Value of Diversity

Graham Sinden



Environmental Change Institute
University of Oxford



Key Concepts

- Describing the UK's renewable resources
 - Geographic Diversity
 - Technology Diversity
 - Backup

Renewables and Intermittency

“The Government’s energy policy is hopelessly unrealistic...over-optimistic and fails to address the fundamental problem with all renewable sources – they are intermittent.”

Royal Academy of Engineering – News Release, 2002

■ Intermittent Supply

- Wind
- Solar
- Wave
- Tidal current
- dCHP

■ Non-Intermittent Supply

- Energy Crops
- Energy from Waste
- Landfill Gas
- Hydro
- Tidal barrage

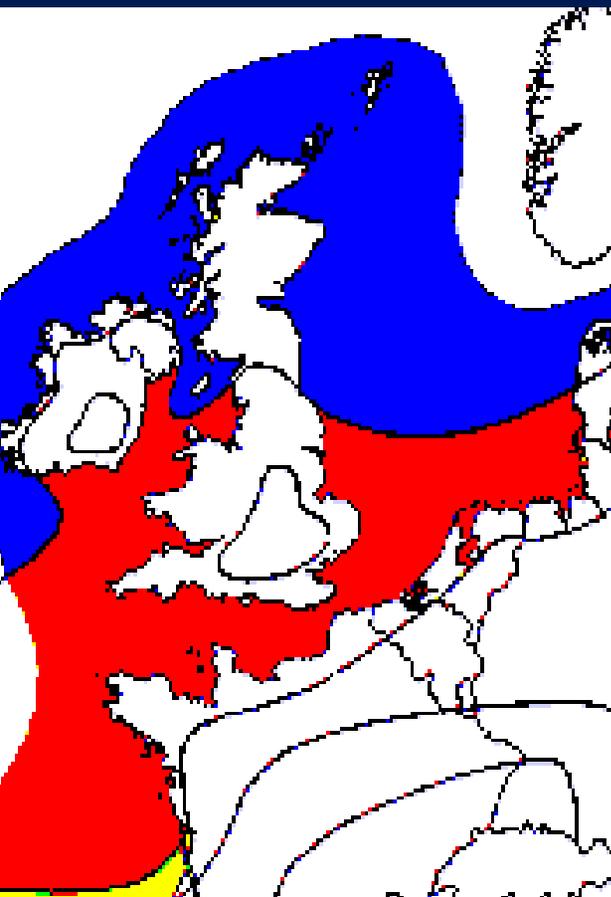
In 2002, 83% of renewable electricity in the UK was from non-intermittent sources, and just 17% from intermittent sources.

(after DUKES, 2002)

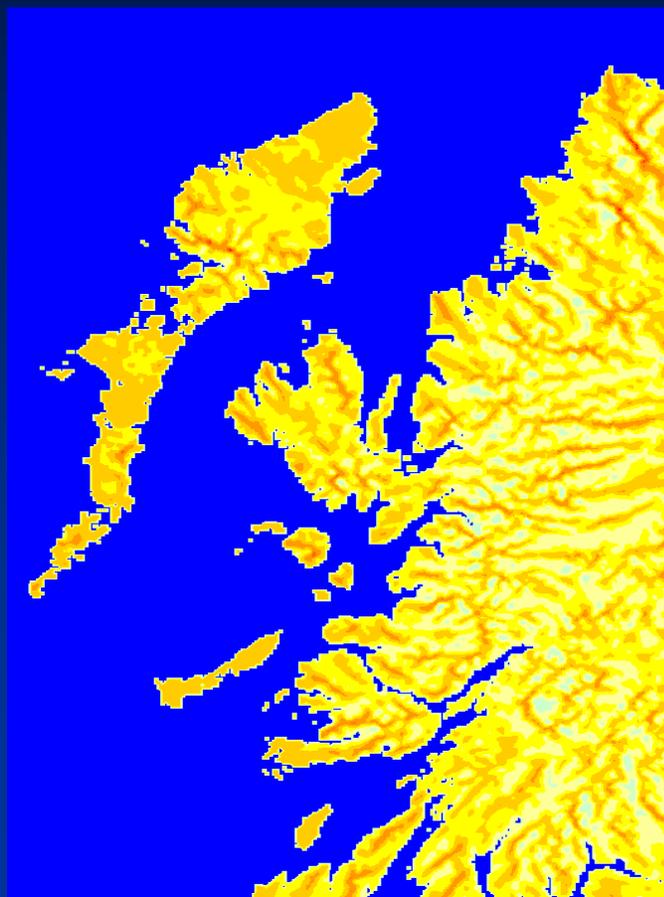
UK Renewable Resources

Wind and Solar

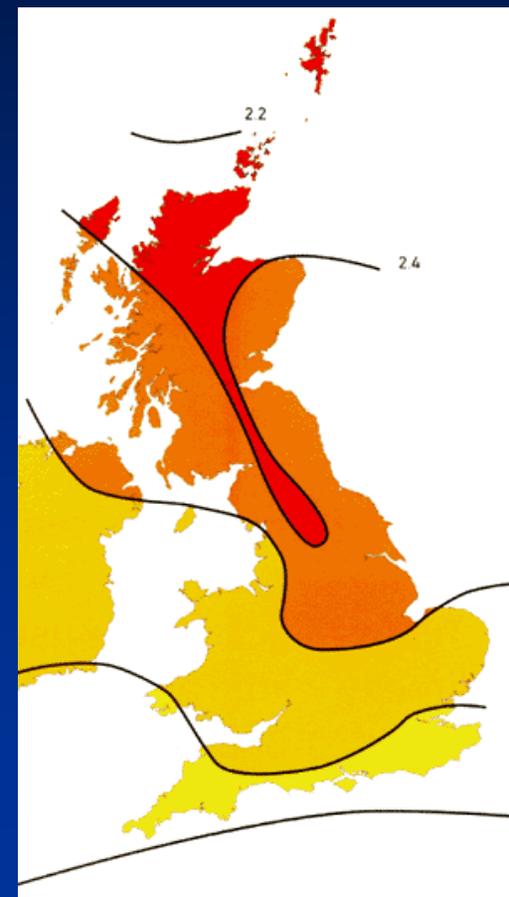
Offshore Wind



Onshore Wind



Solar



Geographic Diversity - UK Wind Resource

“...we must not lose sight of the fact that the wind only blows a third of the time...”

Tom Foulkes (Director-General of the Institute of Civil Engineers) – Press Release

Geographic Diversity - UK Wind Resource

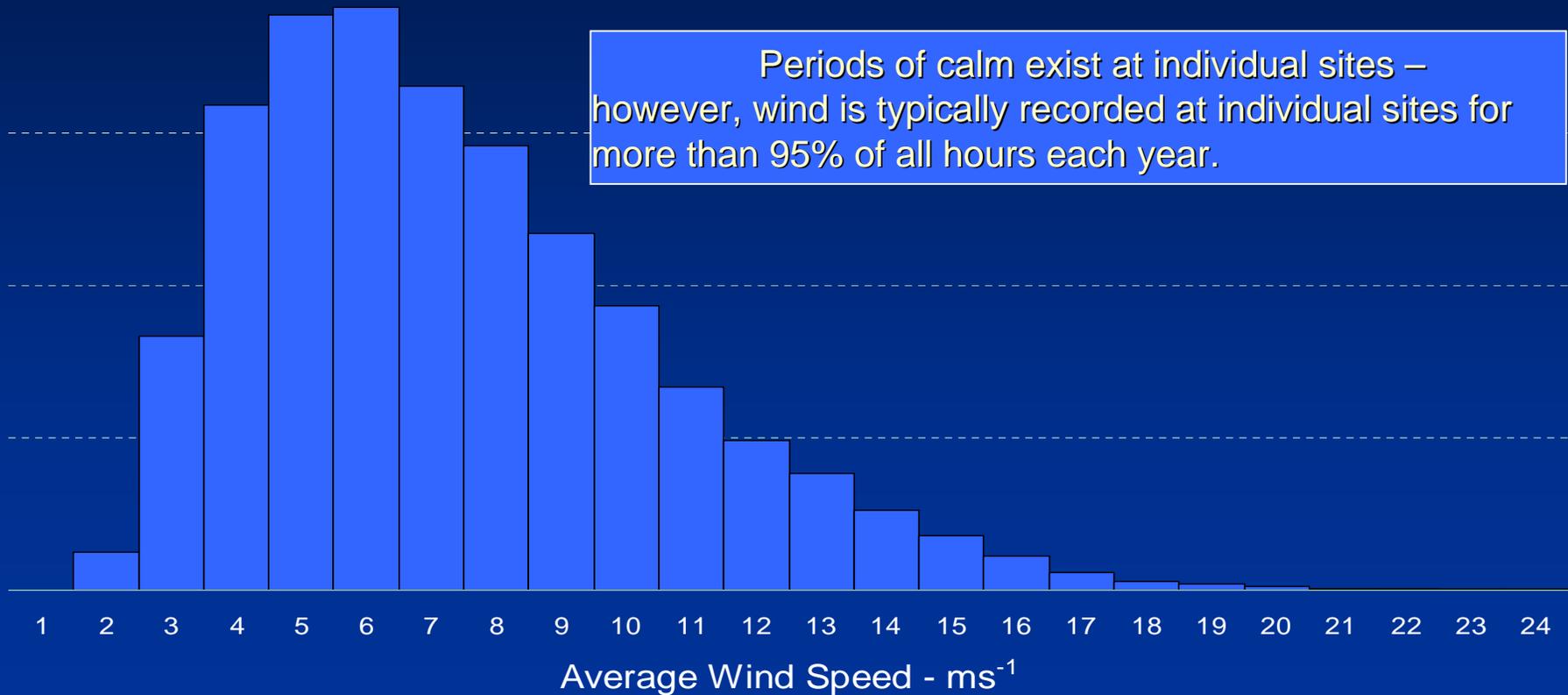
Distribution of Average Hourly Wind Speed across the UK

Data period ~15-20 years, min 50 recording stations per hourly record, ms^{-1} .

Analysis of surface wind speeds from 50-60 sites across the UK shows that the wind blows somewhere in the UK every hour of every day of the year.

Periods of calm exist at individual sites – however, wind is typically recorded at individual sites for more than 95% of all hours each year.

Proportion of Time



Geographic Diversity - UK Wind Resource

“There are several periods during a year when the UK is covered by an anticyclone and there is no wind and consequently no waves.”

Prof Ian Fells (Fells & Associates) - Submission to House of Lords Enquiry into Renewable Energy

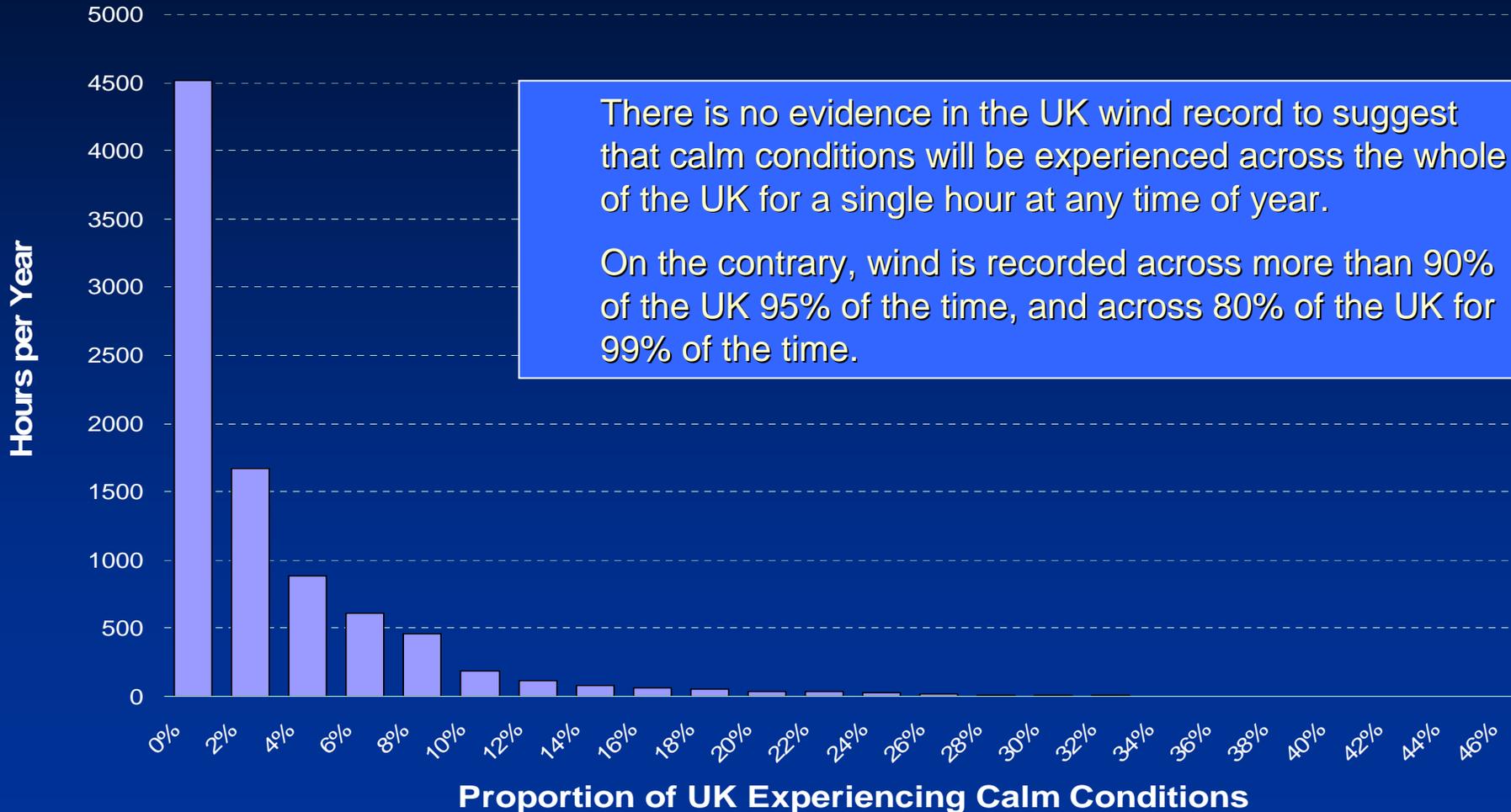
“...you can have a period of two weeks when the temperatures are all below zero and there is no wind...”

David Kerr (Institute of Civil Engineers) – Press Release

Geographic Diversity - UK Wind Resource

Proportion of the UK Experiencing Calm Conditions

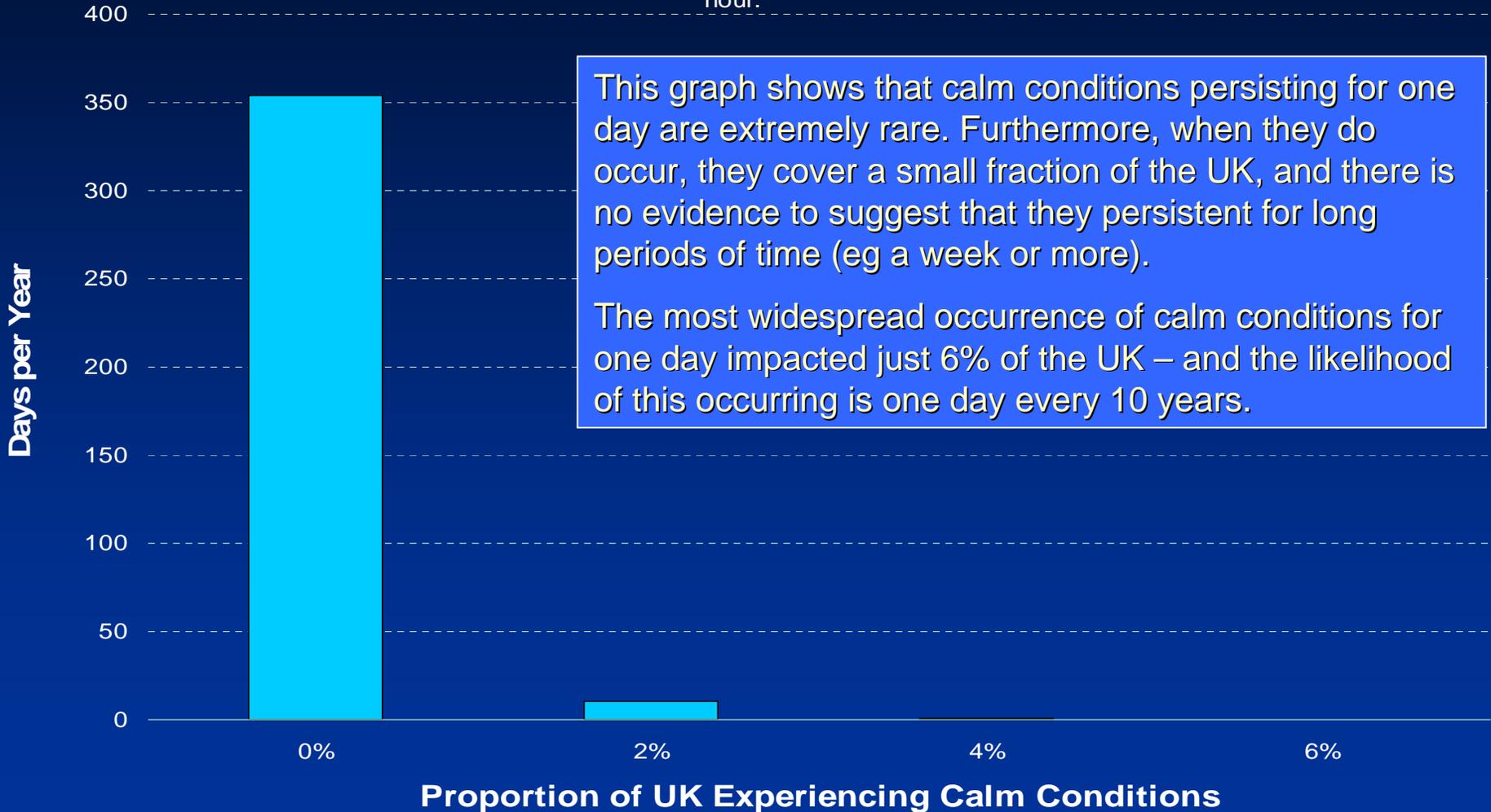
Persistence = 1 Hour, Period ~15-20 years, Calm=0ms⁻¹, 50 or more records per hour.



Geographic Diversity - UK Wind Resource

Proportion of the UK Experiencing Calm Conditions

Persistence = 24 Hours (midnight to midnight), Period ~15-20 years, Calm=0ms⁻¹, 50 or more records per hour.

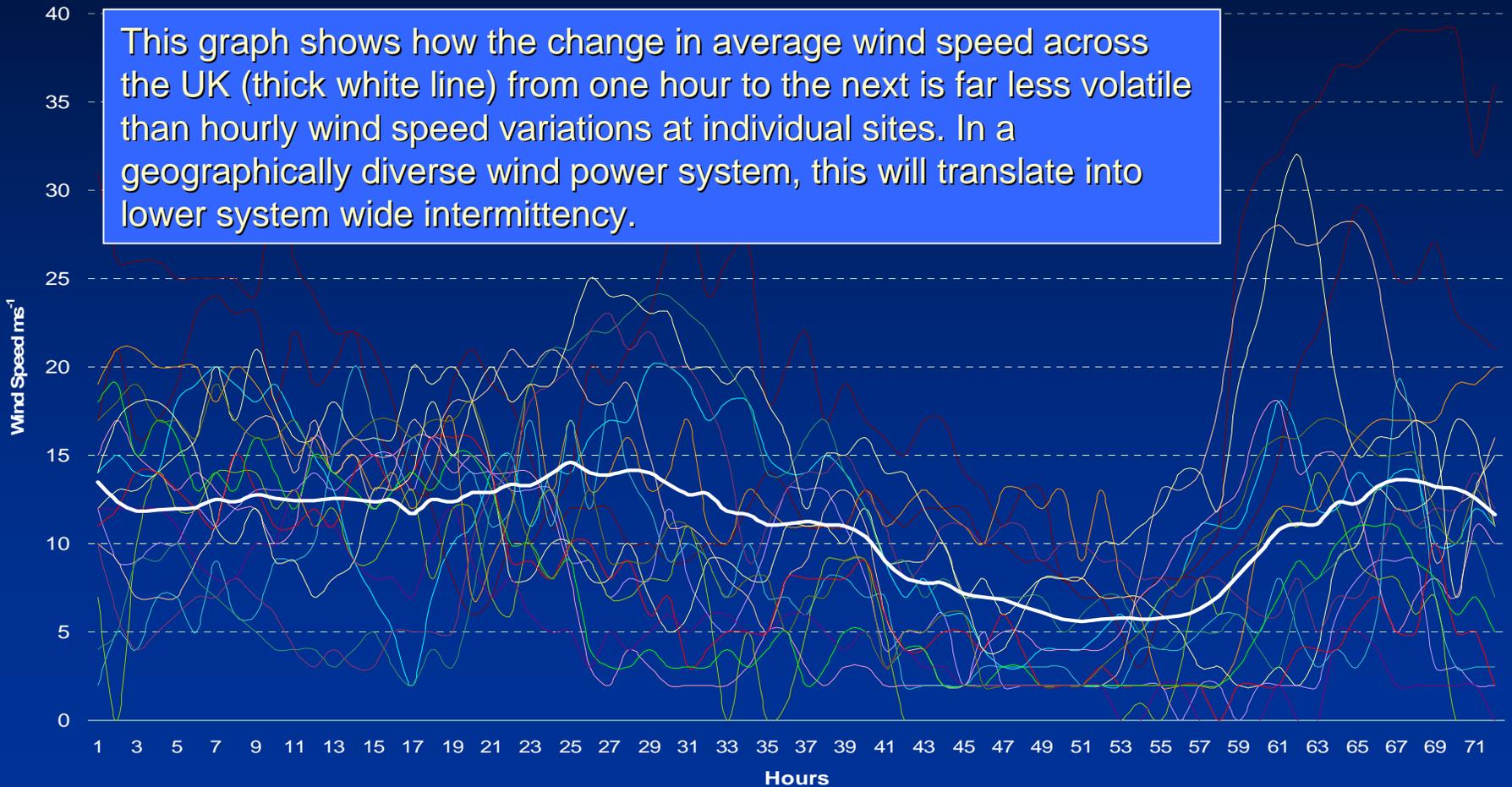


Geographic Diversity - UK Wind Resource

Site Specific and Average Hourly Wind Speed - UK

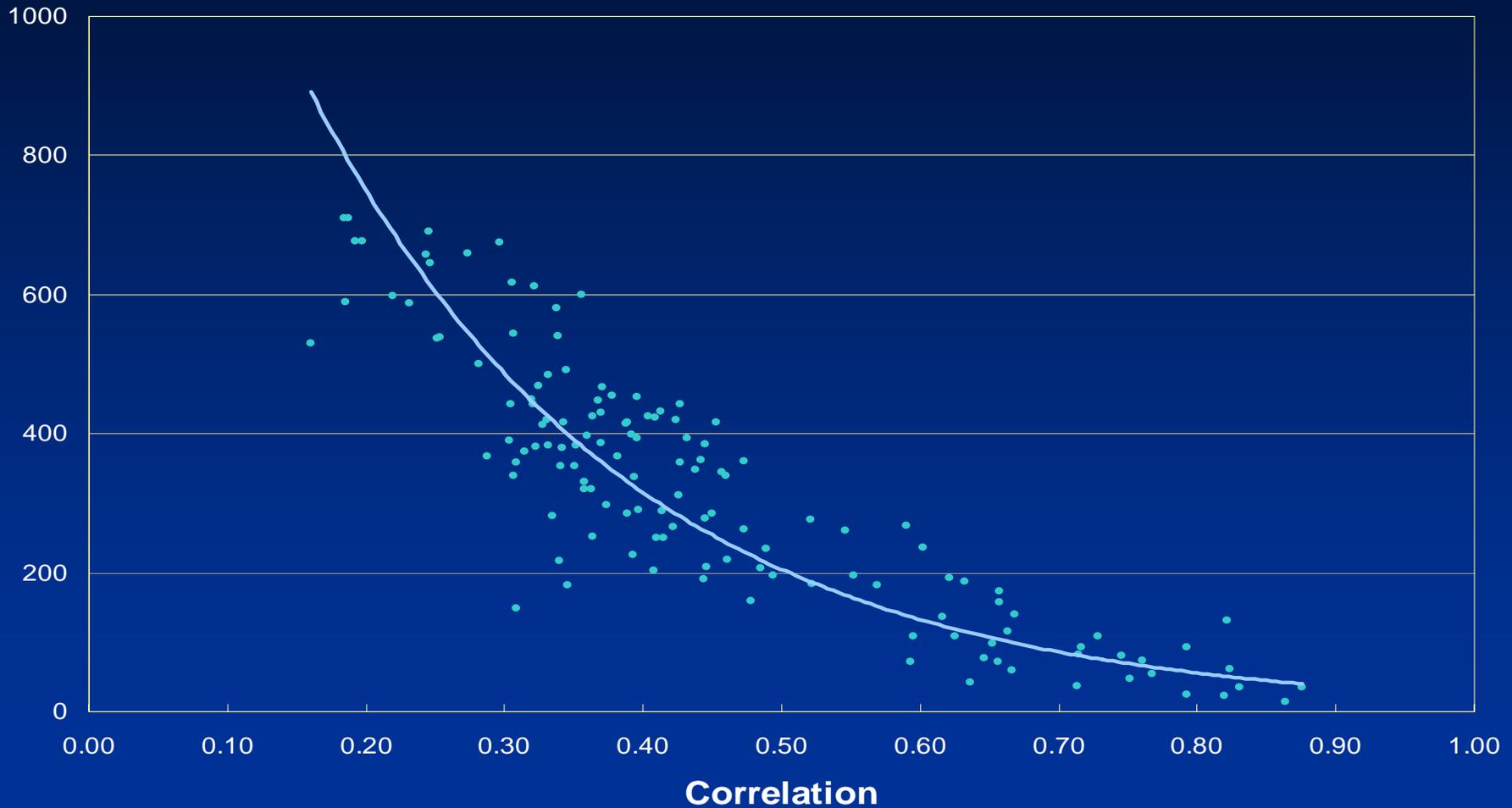
Surface wind speed, 72 hours, 50 or more records per hour (average trace), ms^{-1}

This graph shows how the change in average wind speed across the UK (thick white line) from one hour to the next is far less volatile than hourly wind speed variations at individual sites. In a geographically diverse wind power system, this will translate into lower system wide intermittency.



Geographic Diversity - UK Wind Resource

Correlation Between Geographically Diverse Wind Power Sites - Great Britain



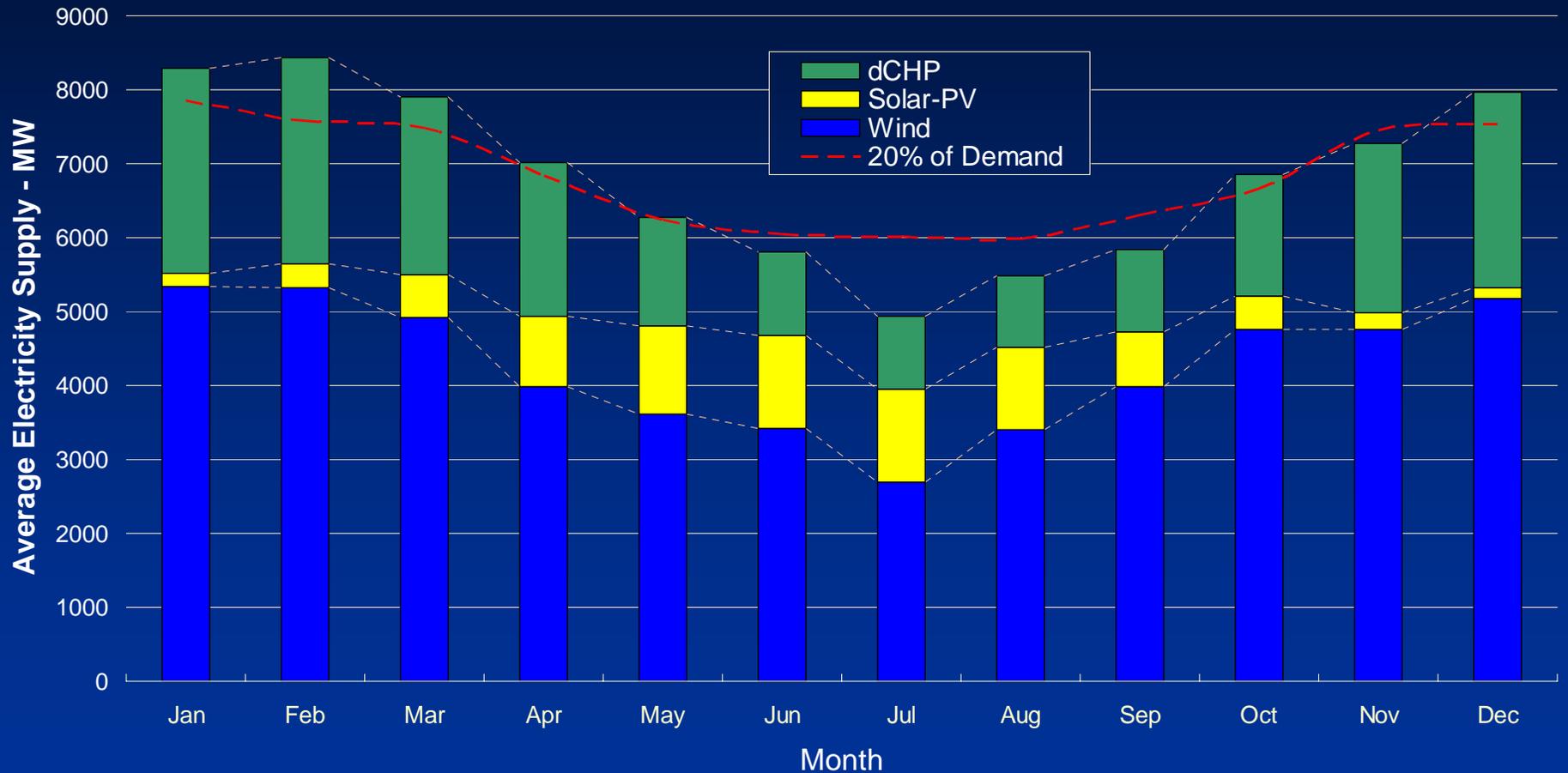
Technical Diversity – UK Wind, Solar, dCHP

Different renewable generating technologies will produce different patterns of electricity supply.

Identification of complementary patterns of supply will reduce portfolio-wide variability from intermittent renewables, reducing backup requirements.

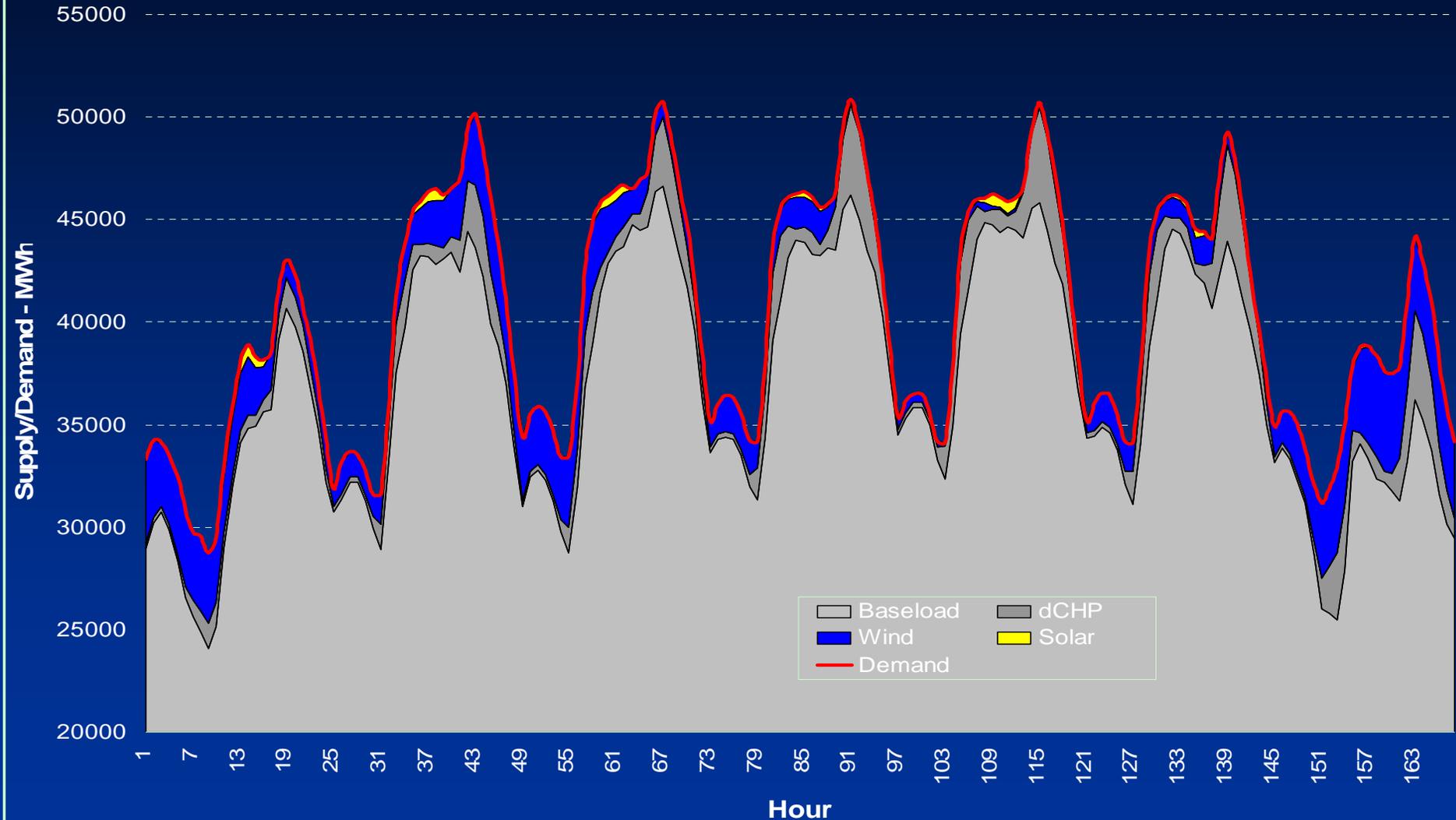
Technical Diversity – UK Wind, Solar, dCHP

Comparison of Intermittent Supply Sources by Month



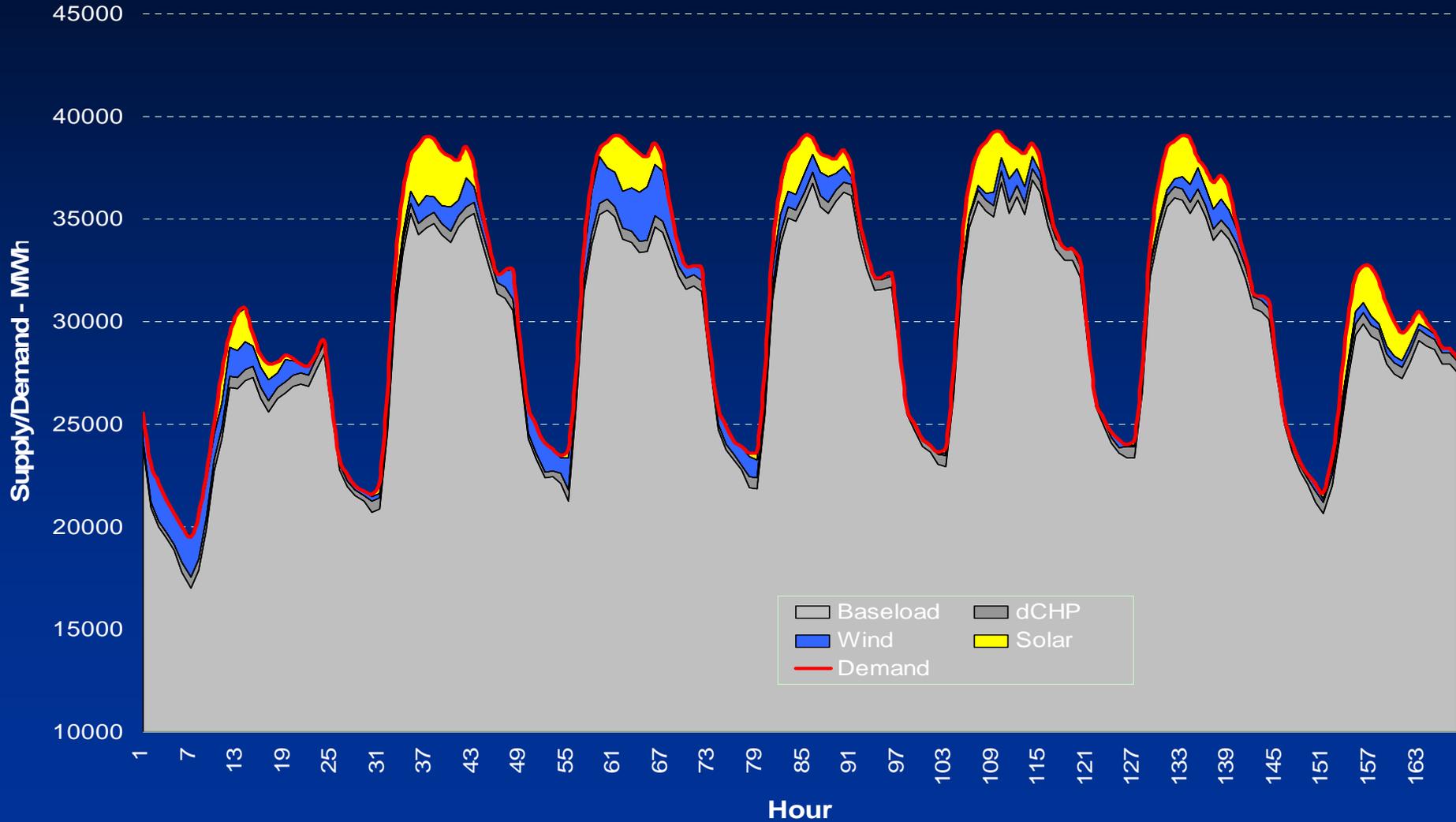
Technical Diversity – UK Wind, Solar, dCHP

Electricity Demand and Renewable Supply by Type - January 6-12, 1999



Technical Diversity – UK Wind, Solar, dCHP

Electricity Demand and Renewable Supply by Type - July 6-12, 1999



Diversity, Intermittency and Backup

“The brutal reality is that 20GW of wind power cannot be accommodated in the UK electricity system. Neither private investors nor government are likely to fund the additional 20GW of conventional stand by generating capacity required to cope with wind turbines falling idle or under-performing because of weather fluctuations.”

Prof M.Laughton & Prof B.Whittington

Our Energy Future? A Comment on the PIU's Energy Review

Diversity, Intermittency and Backup

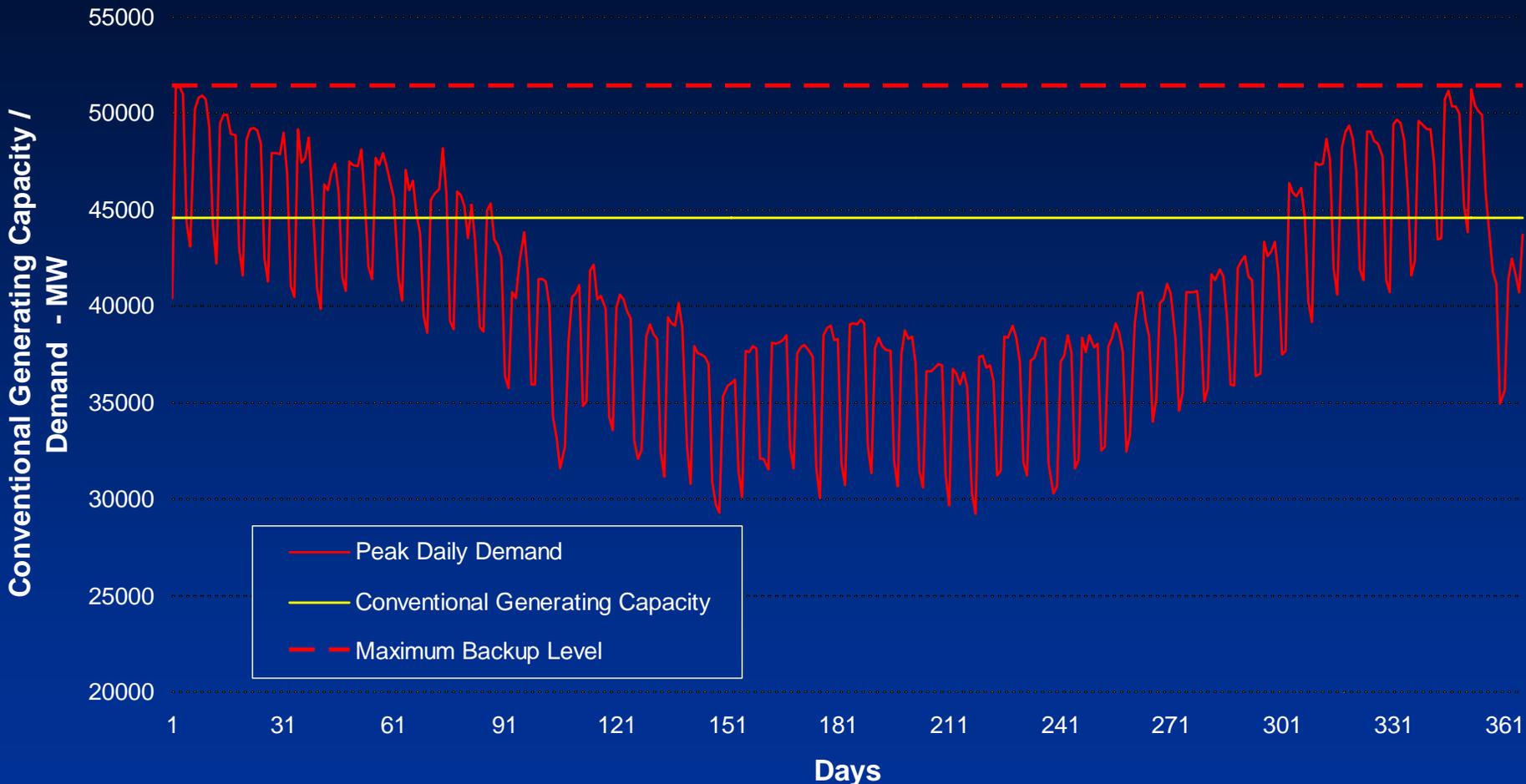
Key Points in Sizing Backup

1. The maximum additional backup required because of intermittent electricity generation is never greater than the equivalent amount of conventional generating capacity being displaced.
2. The actual additional backup required because of intermittent electricity generation is determined by the “worst” hour of high demand and low intermittent electricity production.

Diversity, Intermittency and Backup

Net Backup Requirement

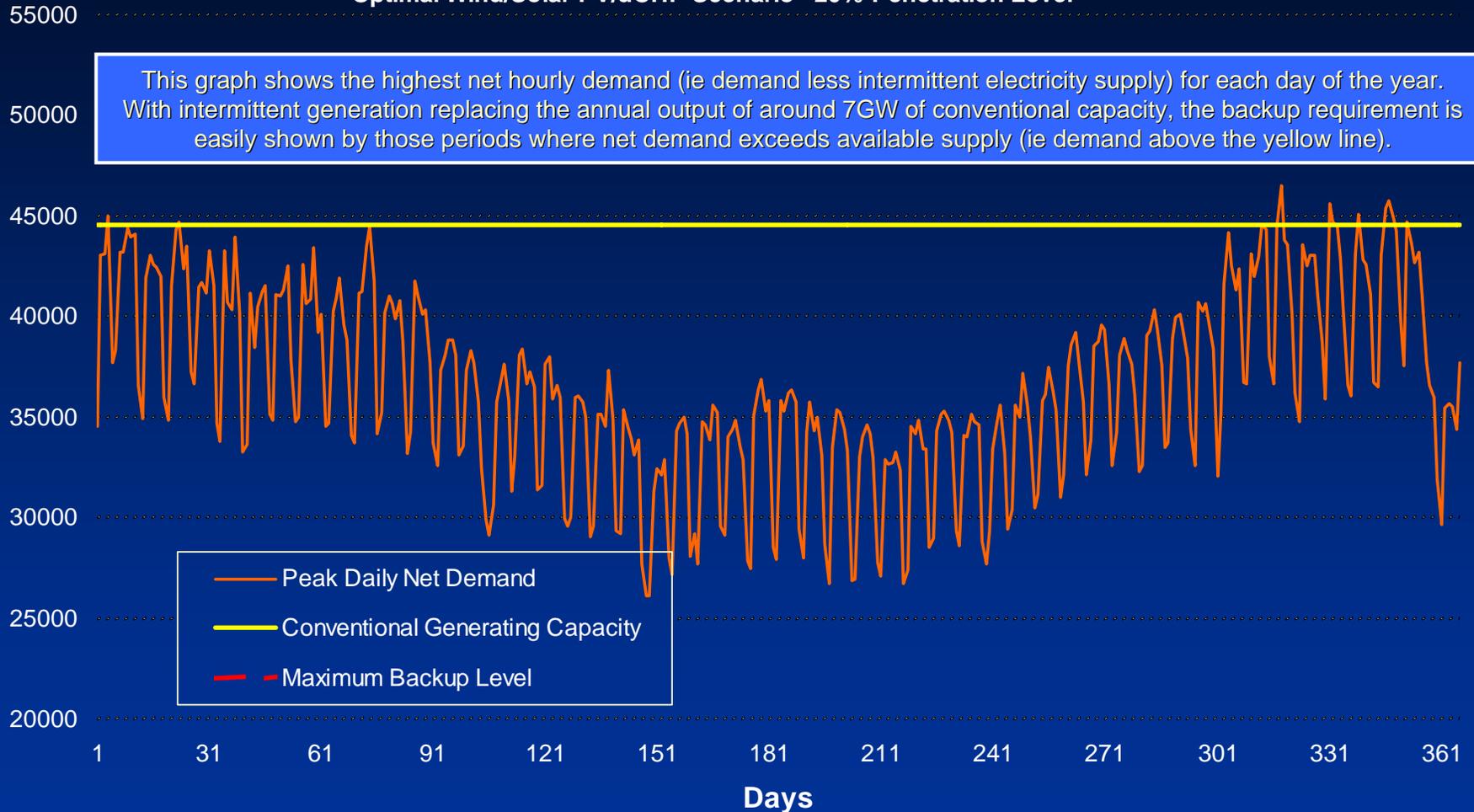
Optimal Wind/Solar-PV/dCHP Scenario - 20% Penetration Level



Diversity, Intermittency and Backup

Net Backup Requirement

Optimal Wind/Solar-PV/dCHP Scenario - 20% Penetration Level



In Summary

- The variability of electricity supply from intermittent renewables can be reduced through
 - Geographic diversity
 - Technology diversity
- The challenge is to ensure that these benefits are recognised by the market.

For further information on renewable electricity generation,
intermittency and system security, contact

Graham Sinden

Environmental Change Institute

University of Oxford

Graham.sinden@eci.ox.ac.uk